**Materials science**

Is an interdisciplinary field concerned with the understanding and application of the properties of matter? Materials scientists study the connections between the underlying structure of a material, its properties, its processing methods and its performance in applications

**Materials science**

The scientific study of the properties and applications of materials of construction or manufacture (such as ceramics, metals, polymers, and composites)

**Material source**

The geographical origin of naturally occurring vegetable, animal or geological materials which either have been used to form an object or form specimens or deposits in their

**Use of material science**

Materials Science and Engineering is the study of all materials, from those we see and use every day such as a glass or a piece of sport equipment to those used in aerospace and medicine.

**Importance of material science**

It involves applications from number scientific disciplines that contribute to the creation of new materials. Chemists play a predominant role in materials science because chemistry provides information about the structure and composition of materials, as well as the processes to synthesize and use them.

**Historical background** of **materials**

Tools allowed hominids to become the masters of their environments, to hunt, to build, and to perform important tasks that made life easier for them. The first tools were made out of stone. Thus, historians refer to the period of time before written history as the Stone Age.

Copper is one of those metals that man started using very early. As a matter of fact, copper was the first metal that man discovered in 9000 BCE. The other metals used in pre-historic times were gold, silver, tin, lead, and iron.

Materials are important to mankind because of the benefits that can be derived from the manipulation of their properties. Examples include electrical conductivity, constant, magnetization, optical transmittance, strength and toughness. All of these properties originate from the internal structures of the materials. Structural features of materials include their types of atoms, the local configurations of the atoms, and the arrangements of these configurations into microstructures

Materials can be divided into various classes which may constitute separate fields such as metals, polymers, ceramics, composites, semiconductors, bio-materials and nano materials. Materials science is a broad field and can be considered to be an interdisciplinary area. Included within it are the studies of the structure and properties of any material, the creation of new types of materials, and the manipulation of a material’s properties to suit the needs of specific application.

**8000 BC  -** First use of Cu, in the area we presently call Iraq.  Found in rock formations in the metallic state, dug up and beaten into shape, to form tools, ornaments, etc..  About this same time the first farming villages appear.

**c. 5000 BC  -** Pottery made and Cu extracted from its ore.  These two materials technologies are related.  High temperatures are needed to extract metal from ore, more than just sticks of wood and an open fire.  Pottery ovens, properly ventilated, provided the needed temperatures.  About this same time gold was discovered, dug up out of the ground and beaten into various shapes.

**c. 3500 BC  -** Hardening of Cu with Sn.  Beginning of the Bronze Age.  The alloy is considerably stronger than the pure metals.

**c. 1500 BC  -** Production of metallic iron from its oxide ore.  This requires temperatures considerably higher than extraction of Cu and requires charcoal as a reducing agent.  This was first done by the Hittites in present-day Turkey.  Fe has important advantages over Cu:  It is much more common and cheaper.  The Fe-C alloy is much harder and stronger than Cu alloys so one can produce better tools and weapons with sharper edges.  Knowledge of Fe smelting was so valuable that the Hittite kings apparently restricted the export of Fe weapons and kept secret their ironworking techniques.  The Iron Age led to many changes in society.  With a sharp Fe axe one could chop down trees more easily for building wooden houses.  This led to the deforestation of much of Europe.

**c. 1200BC** - Earliest quenching and tempering of steel to harden it.  Steel is an alloy of Fe and C.  This began in Greece.  Homer refers to this process in his Odyssey, describing the blinding of Cyclops.

**c. 900 BC** - Hardened steel tools & weapons were in widespread use, displacing the older bronze technology.

**c. 1903** - Precipitation hardening of Al, the first nano-technology.  This process is often referred to as age hardening.  The Wright Bros. used an alloy of Al + 8wt% Cu for the engine in their plane.  Fe engines were too heavy to get off the ground.  Similar Al-Cu alloys have been used extensively in the aircraft industry ever since, for the main structure and skin of the aircraft. In the literature you will often see this discovery attributed to Alfred Wilm who published a paper on the subject in 1911 and received a patent.

The production and heat treatment of Fe-C alloys and Al-Cu alloys are among the greatest technological developments in human history.  These developments have had a huge impact on society and our standard of living.

**TERMINOLOGIES**

**Alloy**

A homogenous mixture of two or more metals made up of distinct components or elements.

**Annealing**

1. To heat (glass or metal) and slowly cool it to toughen and reduce brittleness.

2. To temper

**Atom**

A unit of matter, the smallest unit of an element, having all the characteristics of that element and consisting of a dense, positively charged nucleus surrounded by a system of electrons

**Carbon** A non-metallic chemical element found esp. in all organic compounds; diamond and graphite are pure carbon.

**Carbonaceous**

Man- made fibers. Created using heat

**Catalyst**

A substance serving as the agent in the speeding up or sometimes slowing down of a chemical reaction by adding a substance which itself is not changed thereby.

**Compound** A substance consisting of atoms or ions of two or more different elements in definite proportions, usually having properties unlike those of its constituent elements

**Density**

A comparison of the relative weights of materials

The ratio of mass to unit volume expressed in grams/cm3 for solids and liquids and grams/liter in gases (density = mass/volume

**Ductility**

The ability of a material to be stretched and or compressed without fracture

**Durometer**

Technically, this term refers to the hardness of a material and ranges from a skin soft 0A to a harder than a car tire 95A.

There are different scales used to determine a materials hardness that we should be aware of. Please take some time to research them.

**Elasticity**

The ability of a material to recover its original shape after deformation

**Element** A substance composed of atoms having an identical number of protons in each nucleus and not reducible to a simpler substance.

**Fatigue Resistance**

The ability of a material to withstand cyclic loading with limited failure

**Ferrous** Of, containing, or derived from iron (a metallic chemical element, the most common of all metals)

**Fiber**

1. A thread like structure that combines with others to form animal or vegetable tissue.

2. Any substance that can be separated into threadlike parts for weaving

3. Texture

4. Character or nature

5. Roughage

**Graphite** Crystalline form of carbon used in pencils, as lubricant, and formed into man -made fibers etc.

**Melting Point**

The temperature at which a solid becomes liquid at standard atmospheric pressure

**Monomer**

A substance composed of molecules capable of reacting with like or unlike molecules to form polymers.

Any small molecule that can undergo a reaction in which it is incorporated into a large molecule containing many similar units

Common monomers are vinyl acetate, styrene, butadiene and vinyl chloride. (It is appropriate to consider hydrocarbons as polymers of methylene!)

**Non Ferrous**

Of or containing no iron.

**Polymer**

Substance composed of molecules characterized by the repetition (neglecting ends, branch junctions, and other minor irregularities) of one or more types of monomeric units\*

**Polymerization**

The process in which many small molecules (molecular weight

~100) are joined together to form a few, much larger molecules (molecular weight 10 000 - 10 000 000). The two ways in which this happens are chain-growth and step-growth polymerization.

**Plasticity**

The ability of a material to be formed to a new shape without fracture and retain that shape after load removal

**Plastisizer**

A compound added to a polymer to make it softer and more flexible. These are usually small molecules with dangling bits that can disrupt the packing of polymer chains.

**Strain**

A material’s reaction to a stress

**Strength**

The ability to withstand load, to resist an applied force without failure

**Stress**

The reference to the force being applied

**Stress Relieved**

This term is used to indicate that a specific process was used to align the molecules of a material in their most efficient configuration.

**Substance**

a. that which has mass and occupies space; matter

b. A material of a particular kind or constitution.

**Tensile Strength**

The word tensile means, “to pull apart” Tensile strength is the resistance of material to being pulled apart and is expressed in lbs. per square inch.

The maximum tensile load per unit area of original cross section, within the gage boundaries, sustained by the specimen during a tension test

It is expressed as PSI. Tensile load is interpreted to mean the maximum tensile load sustained by the specimen during the test, whether or not this coincides with the tensile load at the moment of rupture.

**Tensile Modulus**

When a bar is pulled in tension, it has to get longer. The tensile modulus is used to calculate how much longer it will get when a certain load is applied to it. Units are normally millions of pounds per square inch. (10 6 PSI) - Giga Pascals (gPa).

Higher numbers indicate materials, which will not elongate as much as others when they are being compared under equal tensile loading conditions.

**Thermal Conductivity**

This property is known as the K factor. It is a measure of the transfer of heat by conduction. It tells how much heat is transferred from one side of a plate to the other side. It is measured as BTUs per hour per unit area (square feet) for a thickness of one inch and temperature difference of one degree.

**Thermodynamic**

The word 'thermodynamic' comes from roots that mean 'heat' and 'motion'. In a chemical reaction where chemical bonds rearrange to give more stable products, the energy that was stored in the bonds will be released as heat. In many chemical reactions where there are a number of possible products, one will be the most stable (give the greatest release of heat) – this will be the thermodynamic product. This might not be the product that is actually formed, since another possible product might be formed more rapidly - the kinetic product.

**Thermoforming**

This is a term used to describe several techniques for making products from plastic sheets. In a vacuum forming process, hot thermoplastic sheets are draped over a mold. Removing air from between the mold and the plastic creates a vacuum that draws the plastic to the surface of the mold.

**Thermoset**

A polymer that, when heated ('thermo') does not become soft and deformable

This is usually because it is cross linked, and the molecules comprising it cannot move past one another unless chemical bonds are actually broken - which leads to the decomposition of the polymer. Phenol-formaldehyde resin is an example.

**Thermosets** Reference to the make- up of monomers that when formulated in a liquid state solidifies by chemical reaction. Because of the chemical reaction the material is often not adjustable once the mixture has set.

**Thermoplastics**

Reference to the make- up of monomers that when formulated in a liquid state solidifies by cooling

In particular the materials capability to be re-melted repeatedly

A polymer that, when heated ('thermo') becomes soft and deformable ('plastic')

Examples are poly (styrene) and poly (ethylene)

**Toughness**

The ability of a material to withstand sudden or shock loading forces without fracture

**Viscosity**

This term indicates how well a material does or does not flow and is measured in centipoise (CPS). Water has a viscosity of 1 CPS and flows easily. Molasses has a viscosity of 100,000 CPS and is very thick resulting in a much slower flow rate.

**Volume Resistivity**

The property of a material to resist electric conductivity

**PLASTER OF PARIS TECHNIQUES**

It is important to remember that expertise is not acquired overnight, either from a textbook or in the classroom, but in the process of the actual day – to – day application of every variety of the plaster cast.

**Definition**

A cast may be defined as;

* A method of temporary immobilization that circumferentially incorporates a part or parts of a body.
* The term cast implies that the plaster or synthetic encases the entire part of the body.
* Casts and Splints are hard wraps used to support and protect injured bones, ligaments, tendons, and other tissues.
* Externally applied structure that holds bone in one position.
* Is a rigid protective material of plaster or synthetic.
* Is a rigid device applied to immobilize the injured bones and promote healing. It is applied to immobilize the joint above and below the fractured bone so that the bone won't move during healing. These are applied on clients who have relatively stable fractures.
* An orthopedic cast, body cast, plaster cast, or surgical cast, is a shell, frequently made from plaster, encasing a limb (or, in some cases, large portions of the body) to stabilize and hold anatomical structures, most often a broken bone (or bones), in place until healing is confirmed. It is similar in function to a splint.
* Nowadays bandages of synthetic materials are often used, often knitted fiberglass bandages impregnated with polyurethane, sometimes bandages of thermoplastic.

**Various forms of Plaster of Paris cast**

* Slab: only a part of circumference of limb is incorporated.
* Cast: encircle whole circumference of the limb.
* Spica.
* Brace.

**The major categories of casts are:**

* Upper extremities.
* Lower extremities.
* Spinal and Cervical.
* Spica casts.
* Extremity cast incorporates all or a portion of the designated extremity.
* Spinal and cervical casts incorporate all or a portion of the trunk of the body or the cervical area.
* Spica refers to a cast that incorporates part or the entire trunk of the body and a part or all of one or more extremity.

**CHEMISTRY OF PLASTER OF PARIS**

Plaster of Paris is derived from naturally occurring mineral gypsum. The chemical formula for gypsum is caso4- 2H2O.

The name “Plaster Of Paris” reflects the extensive deposits of gypsum found in the Paris basin in France and more specifically the Montmartre district.

Gypsum is converted into Plaster Of Paris by pulverization and subsequent calcinations. Calcinations transform the crystalline gypsum to an amorphous state and require high temperatures to release water. The reaction is endothermic and is described by the following chemical equation.

2 (caso4-2H2O) changes (CaSo4).H2o + 3H20

Gypsum P.O.P water

The chemical reactions are reversible. When water is added to calcinated gypsum or Plaster of Paris, crystalline gypsum reforms with the release of heat. This exothermic reaction explains the warmth associated with cast setting, the amount of heat given off by the cast depends on the amount of plaster used and the temperature of the immersion water.

**SUMMARY**

Plaster of Plaster (what it is)

Gypsum=also calcium sulphate

The basic mineral gypsum in rock form is grounded to a fine powder.

This is heated to drive out three-quarters of its intrinsic water content to become Plaster Of Paris.

The Powder is then mixed with cellulose and chemical solvents in this liquid state- it is impregnated by a heating process on the linear cloth.

NB It is open woven, interlocked fabric which holds the Plaster uniformly and provides additional strength when the compound is applied to produce gypsona in bandages and slabs.

**Setting time**: time taken to change from powder form to crystalline form.

**Drying time**: time taken to change from crystalline form to anhydrous form.

**Average setting time**: 3 – 9 minutes.

**Average drying time**: 24 – 72 hours.

***Factors decreasing setting time:***

* Hot water
* Salt
* Borax
* Resin

***Factors increasing setting time***

* Cold water
* Sugar

**Factors That Affect Setting Times for Casts and Splints**

The dipping water should be kept clean and fresh. In general, the temperature of the water should be tepid or slightly warm for plaster, and cool or room temperature for synthetic tape material. These temperatures allow for a workable setting time and have not been associated with increased risk of significant burns. Applying excess material or using an overly compressive elastic wrap also increases the risk of excessive heat production. Therefore, it is best to use only the amount of splinting material and compression required to stabilize the injury.

***A good rule of thumb is that heat is inversely proportional to the setting time and directly proportional to the number of layers used.***

**Characteristics of P.O.P**

• It soaks rapidly.

• Smooth when moulding.

• It is creamy and

• Innocuous to the skin (Innocuous-harmless)

• It sets fast- can be moulded as desired.

• Light cast translucent to X-rays.

• It has a combined strength with durability.

• Low plaster loss properties depending with the brand, examples, gypsona.

**Purpose of cast:**

* Immobilize parts of the body.
* Hold bone fragments in reduction (reduction is bringing the fractured on its anatomical position).
* Apply uniform compression.
* Stabilize joint.
* Correct deformities.
* Support weakened limb.
* Permit early weight bearing on affected side.

**The following are the indications for the use of Plaster of Paris.**

* Immobilization of fractures.
* Immobilization of diseased bones and joints.
* Correction of deformities e.g. club foot.
* Prevention of deformities.
* Emergency Splintage.
* Making of negative and positive casts.
* Immobilization in the treatment of burns and soft tissues injuries.

1. **Immobilization of fractures**

* It must always be remembered that the surrounding soft tissues are damaged when a bone is broken.

**When P.O.P is used**

* Accuracy of alignment is secured and maintained.
* Immobilized limb can be x-rayed and progression towards healing may be observed without any disturbance to the fixation of the limb.
* The patient can retain at least some mobility.
* With Plaster fixation body function is retained during immobilization. 2. **Immobilization of the diseased bones or joints.**
* Resting the diseased bones/joints to prevent complications and deformities resulting from the original conditions. e.g. Chronic Osteomyelitis.
* 3. **Correction of deformities**
* This can be obtained by two methods.
* (a) **Serial Plaster**
* It is whereby procedure routine is repeated as often as necessary using P.O.P so that you can achieve the correction of the deformity e.g. club foot.
* (b) **Wedging and turnbuckle correction of deformities**
* Two instances where wedging may be used.
* (i) Adjustment of the alignment of a fracture.
* (ii) In the correction of basic deformities in congenital club foot.
* NB:
* Care should be taken when cutting a Plaster of Paris.
* **4. Prevention of deformities**
* A patient may sustain a wrist drop or foot drop due to variety of causes. If light removable Plaster Shells/ Splints are made.
* (i) Power may be restored.
* (ii) Function may also be restored.
* **5. Emergency Splintage**
* Packed units consisting of Plaster Slab and circular paper bandage are available as First Aid kits.
* **Reasons (Indications) of Splintage for the limb (supplementary notes)**
* P.O.P is used for the following reasons in traumatic and orthopaedic conditions.
* To support fractured bones, prevent movement of the fragment and restoring damaged soft tissue.
* To stabilize and rest limbs where ligamentous injury has occurred.
* To correct deformity- achieved by wedging of the cast.
* To support and immobilize joints.
* To support and immobilize limbs where nerve and tendon repairs have been carried out.
* To make a removable splint to aid mobilization or prevent deformities, as in rheumatoid arthritis.
* To rest infected tissues, e.g cellulitis.
* To make a negative mould of the body for orthotic use.
* To prevent patients from removing their dressings and disturbing wounds.
* **Advantages of Plaster of Paris**
* Low allergic response.
* Offers rigid protection.
* Easy to apply.
* Inexpensive.
* Shape better than synthetic cast because of easy mouldability.
* **Disadvantages of Plaster of Paris**
* Causes circulatory catastrophes’.
* Causes pressures sores
* Are heavy and inconvenient to the patient.
* Stiffness of joint
* Bones become osteoporotic.
* Uncertain immobilization.
* Not water proof.
* Loss of position of the fractures.
* Difficult to inspect the limb so it may conceal trouble e.g. wound breakdown.
* Long drying.
* May crumble and disintegrate at edges.
* **Using Sub Standard “Plaster Of Paris”**
* Exothermic reactions – serious burns to patients.
* Medico – Legal costs.
* Serious health hazards – breathing excess dusts.
* Huge costs to the hospitals – repeat applications and rejects.
* **Benefits of using standard “Plaster Of Paris” (advantages)**
* Easy, creamy application.
* Excellent moulding properties.
* Low Plaster loss.
* Flexible working time.
* Strong.
* Smooth finish.
* Cost – effective.
* Versatile range.
* Easy removal.
* Customisable.
* **Rules of application of Plaster of Paris**
* 8 inch for thigh, 6 inch for leg and 4 inch for forearm.
* One joint above and one joint below.
* Moulded with palm and not with fingers to avoid indentation.
* Joints should be immobilized in functional position.
* Not too tight or too loose i.e. adequate padding.
* Dip pop vertically in water till air bubble ceases to come.
* Uniform thickness of plaster is preferred.
* **Cast application**
* Before casting material is applied (plaster or synthetic), a "stockinette" is usually placed on the skin where the cast begins and ends (at the hand and near the elbow for a wrist cast). This stockinette protects the skin from the casting material.
* After the stockinette is placed, soft cotton patting material (also called cast padding or Webril) is rolled on. This cotton patting layer provides both additional padding to protect the skin and elastic pressure to the fracture to aid in healing.
* Next, the plaster or synthetic cast material is rolled on while it is still wet.
* The cast will usually begin to feel hard about 10 to 15 minutes after it is put on, but it takes much longer to be fully dry and hard.
* Be especially careful with a plaster cast for the first 1 to 2 days because it can easily [crack](http://www.emedicinehealth.com/script/main/art.asp?articlekey=13763) or break while it is drying and hardening. It can take up to 24 to 48 hours for the cast to completely harden.
* **Plaster casts**
* A plaster cast is made from rolls or pieces of dry muslin that have [starch](http://www.emedicinehealth.com/script/main/art.asp?articlekey=162241) or dextrose and calcium sulfate added.
* When the plaster gets wet, a [chemical reaction](http://www.emedicinehealth.com/script/main/art.asp?articlekey=6760) happens (between the water and the calcium sulfate) that produces heat and eventually causes the plaster to set, or get hard, when it dries.
* A person can usually feel the cast getting warm on the skin from this chemical reaction as it sets.
* The temperature of the water used to wet the plaster affects the rate at which the cast sets. When colder water is used, it takes longer for the plaster to set, and a smaller amount of heat is produced from the chemical reaction.
* Plaster casts are usually smooth and white.
* **Synthetic materials for casting**
* Synthetic casts are also applied starting from a roll that becomes wet.
* After the roll is wet, it is rolled on to form the cast. Synthetic casts also become warm and harden as they dry.
* Synthetic casts are rough on the outside and look like a weave when dry. They are available in many colors.
* **Complications of plaster cast can be divided in systemic, which affects whole body or local which affects limb where plaster has been applied.**
* Local complications of plaster can be further classified as immediate and delayed.
* **Systemic Complications of Plaster Cast**
* The most serious is deep venous thrombosis leading to pulmonary embolism. Pain in the calf is an important sign needing medical advice.
* Immobilization in trunk plasters or plaster beds may also produce nausea, abdominal muscle cramps, retention of urine and abdominal distention.
* Good nursing and diet with regular exercises will help ensure that the initial period of extensive immobilization is achieved without complications.
* **Immediate Local Complications Plaster Cast**
* **Swelling of the Part**
* A plaster produces constricting effect on the limb and most of it is well tolerated but a moderate constriction will produce compression of the veins, damming the blood, and causing swelling, discomfort or pain, and a blue color in the skin and under the nails.
* Temporary remedies such as elevation of the limb and exercising the digits may be tried, but, if persistent, the constriction must be relieved. The cast can be split and eased or bivalved, taking care not to damage the skin.
* **Impaired Arterial Supply**
* A pale skin which is cool and without a palpable pulse indicates that the arterial supply is disrupted. This is a serious complication. Medical advice must be sought immediately.
* Splitting the cast may relieve the arterial compression but sometimes surgery may be necessary.
* Incomplete arterial occlusion may present with pain or aching with loss of power. If in doubt ask for medical advice.
* **Pain**
* Pain has many causes. This may be due to tissue damage at injury or reduction, swelling within the cast, muscle spasm, pressure on blood vessels or nerves, skin irritation or sores. Although diagnosis may be difficult, persistent pain or intermittent acute pain should not be ignored. Medical advice must be sought.
* **Delayed Local Complications of Plaster Cast**
* **Plaster Sores**
* The most common cause of sores is pressure of the plaster on the skin due to poor cast application.
* The patient may report burning, itching or stabbing pain.
* Children may have disturbed sleep and elevated temperature.
* **Signs that may suggest plaster sore**
* Heat and swelling of the digits.
* Increased warmth over a localized area of the cast
* Localized odour.
* Visible pus or staining of the cast.

**PLASTER ROOM ENVIRONMENT**

**Basic Principles**

1. Equipment’s
2. Personnel
3. Records
4. Applications
5. Environment

Casting is being done in cast room and so the distinguishing features of such a location are;

* Sink with a plaster trap to protect blockage of the drains by plaster fragments.
* A floor which can be washed down easily, a gutter should drain into a plaster trap.
* Suitable furniture, couch, chair, table and suspension.

1. **Equipment’s**

They can be placed into two groups;

* That which can protect the patient.
* The implements used for applying and removing cast.

**Protection**

The following is an example of basic equipment’s.

* Dust sheets and other covering material to protect the patient’s clothing are essential.
* Apron and boots will protect the operator.
* Sandbags and supportive pillows for comfort and support of the patient.
* Ring cutters.
* Instruction cards to guide the patient when away from hospital supervision.

**Implements**

The average plaster trolley carries the following items;

* Protective materials – stockinette, felt wool bandages of varying widths.
* Plaster bandages of varying widths.
* Slabs of various widths.
* Plaster Shears and Plaster spreaders
* Plaster scissors, plaster knife, marking pencil.
* Orthopaedic pad/soffban of varying length.
* Electric Plaster Cutter.
* Water buckets.
* Triangular bandages/arm sling/collar and cuff.
* Walking heels, boots/iron for lower limb.
* Steel basin

**Personnel**

* The number of staff required to support the operator will depend on the type of cast to be applied.
* An assistant is very necessary.
* The assistant should be aware of the procedure you want to carry out and sure of the role to play.

**Records**

* A book, card fill/other form of record of each patient should be retained.
* The essential requirements are;
* Name, address and age.
* Diagnosis and plaster type applied, an aesthetic given, manipulation, simple application.
* Instructions given.
* Supplementary appliances given, e.g crutches.
* Date of next return.

**Applications**

* With the equipment’s ready and buckets filled with the water.
* The patient sits comfortably with suitable protective covering.
* The patient must understand what is happening.
* Ensure privacy of the patient.
* The assistant must hold the patient in the desired way.
* Put suitable padding especially around the pressure arears (bony prominence)

**Bandages**

* Immerse the bandage fully in water at angle of 45 degrees so as to encourage the release of the bubbles.
* Hold the bandage gently- otherwise will not penetrate between the layers so effectively.
* After five (5) seconds – the bubbles ceases.
* Keep the leading end free when handling the bandage and squeeze in order to expel water using two hands.
* Keep the leading end free when handling the bandage to the operator.
* Immerse another bandage as the operator unrolls the wet bandage round the limb in an even manner.
* Use circular and spiral turn and no reverse turns should be made.
* Moulding of the bandage should be done by constant smoothing with the palm of the wet hands.
* After obtaining the thickness, the extremities of the cast may require trimming – for free movement of the digits.
* To be done when the cast is still wet not fully dry.

**Slabs**

* Measure the length required and the width.
* Measure the length and the width of the pad.
* Roll the slabs end to end.
* Immerse in water.
* Remove immediately.
* Smooth carefully and quickly on a flat surface.
* Compress the layers together and exclude the bubbles.
* Operator can carry out the remaining procure using gauze roll/crepe bandage.

**CAST PADDING**

The best form of the cast purely for the benefits of the fracture is non – padded cast because it is close contact with the fractured bone.

However, this method has several disadvantages;

1. Limiting allowance for swelling.
2. Friction of the hard cast against the skin and the bone may cause sores.
3. There is no padding to act as a protective barrier against shears and saws on removal of the cast.

***NB.***

Therefore all casts should be adequately padded with the exception of the non – padded removal cast.

Usually two layers of padding are used;

* Tabular gauze/stockinnete
* Cotton wool/soffban

**Tabular Gauze/Stockinette**

The first layer, applied directly to the skin, is synthetic mesh called tabular or thicker stockinette.

Stockinette is more expensive and preferably used with the synthetic casts

**Functions of the tabular gauze/stockinette**

* It helps prevent the limb-hairs from becoming caught in the plaster.
* It removes any roughness caused by the plaster casts edges (the edge of the tabular gauze are turned back over the cast and sealed; this creates a smooth edge which will prevent chaffing of the skin.
* It allows the conduction of perspiration from the limb.
* It aids in the removal of the cast.

***NB.***

Tabular gauze may not be used following operation procedure and where gross swelling is likely to occur as it may be difficult to split the plaster cast.

Orthopaedic padding required. It is unrolled firmly over the full area of the limb to be covered the Plaster of Paris. (Wool Padding)

**Indications of Padding.**

* Where swelling is expected/present i.e. in almost every acute conditions.
* Where the limb is thin and the bones are very superficial.
* When electric plaster cutter are used for removal.
* When wedging is needed.
* It is always wise to protect bony prominences e.g. around joints when any plaster is applied.
* It increases patient comfort.
* To help to absorb blood and serous fluid.

**Synthetic Casting Tape**

**Indications:**

* Non – displaced fracture.
* Fitted when swelling has subsided.
* Long term casting.

**Advantages:**

* Light weight – less bulky.
* Easy to apply.
* Moisture proof.
* Fast drying (15min).
* With different colors.
* Early weight bearing.
* Radiolucent (x-ray vision can past).
* Strength weight ration.
* Feels cooler in hot weather.
* No crumble.

**Disadvantages:**

* Application requires speed and accuracy.
* May bind if tissues swell (rigid).
* High risk for irritation – tissue breakdown under the cast – extra rigidity.
* Expensive.
* Inner layer dries slowly.
* Risk for over physical mobility – light.

**Six advantages to fiberglass impregnated with polyurethane as a cast material.**

* Lightweight.
* Durable.
* Porous (has breathability).
* Waterproof.
* Sets in 5 minutes; weight bearing in 10-20 minutes
* Are radiolucent.

**Six disadvantages to fiberglass impregnated with polyurethane as a cast material.**

* More expensive than plaster cast.
* Doesn't mould as easily as plaster cast.
* Extremely rigid so can cause pressure sores if applied unevenly.
* Mildly irritating (wear gloves when applying).
* Packages of casting material cannot freeze.
* If package has hole, moisture can get in causing it to harden.